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Singular boundary method for global gravity field modelling

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The singular boundary method (SBM) and method of fundamental solutions (MFS) are meshless boundary collocation techniques that use the fundamental solution of a governing partial differential equation (e.g. the Laplace equation) as their basis functions. They have been developed to avoid singular numerical integration as well as mesh generation in the traditional boundary element method (BEM). SBM have been proposed to overcome a main drawback of MFS - its controversial fictitious boundary outside the domain. The key idea of SBM is to introduce a concept of the origin intensity factors that isolate singularities of the fundamental solution and its derivatives using some appropriate regularization techniques. Consequently, the source points can be placed directly on the real boundary and coincide with the collocation nodes.
In this study we deal with SBM applied for high-resolution global gravity field modelling. The first numerical experiment presents a numerical solution to the fixed gravimetric boundary value problem. The achieved results are compared with the numerical solutions obtained by MFS or the direct BEM indicating efficiency of all methods. In the second numerical experiments, SBM is used to derive the geopotential and its first derivatives from the Tzz components of the gravity disturbing tensor observed by the GOCE satellite mission. A determination of the origin intensity factors allows to evaluate the disturbing potential and gravity disturbances directly on the Earth's surface where the source points are located. To achieve high-resolution numerical solutions, the large-scale parallel computations are performed on the cluster with 1TB of the distributed memory and an iterative elimination of far zones' contributions is applied.